

The Phase Behavior of Athabasca Bitumen + Water Mixtures at High Temperature and Pressure

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The phase behavior and thermophysical properties of unconventional hydrocarbon resource + water mixtures at high temperatures and pressures has become a subject of significant interest to both producers and refiners of these resources as operating conditions for production and refining processes, and process concepts have begun to converge. In this work, the phase behavior of Athabasca Bitumen (a hydrocarbon resource where 50 % of the material possesses a nominal boiling point exceeding 524 C containing 18.7 wt% n-pentane asphaltenes) + water mixtures is reported for the first time, in the temperature range (523 to 643 K) and the pressure range (4 to 27 MPa). The synthetic method, which includes systematic measurement of the phase equilibria of mixtures with fixed composition over a wide range of temperatures and pressures, was used in conjunction with a beryllium view cell apparatus equipped with x-ray transmission tomography (Zou, et al. 2007). Phase boundary and phase composition accuracy and precision were validated by reproducing pressure vs. composition at fixed temperature phase diagrams for 1-Methyl naphthalene + water mixtures available in the literature (Christensen and Paulaitis 1992). Liquid-liquid-vapour phase behaviour dominates the phase behavior of Athabasca bitumen + water mixtures. The Athabasca bitumen + water pseudo-binary appears to exhibit Type IIIb phase behavior based on van Konynenburg and Scott classification (Van Konynenburg 1980). Such phase behavior is common hydrocarbons with critical temperatures greater than that of water. Pressure-composition at constant temperature and pressure-temperature at constant composition phase diagrams are presented and discussed. These phase diagrams are expected to provide benchmark data needed to define promising regimes of temperature, pressure and composition for the application of near critical water to hydrocarbon resource processing.